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A BRIEF DESCRIPTION OF THE SMALL-SCALE SAFETY TESTING SYSTEMS AT LAWRENCE LIVERMORE NATIONAL LABORATORY

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Small-scale sensitivity testing is important for determining material response to various stimuli including impact, friction, and static spark. These tests, briefly described below, provide parameters for safety in handling.

1. Drop Hammer (impact sensitivity)

ERL Type 12 drop hammer equipment at LLNL, shown in Figure 1, was used to determine the impact sensitivity. The equipment includes a 2.5-kg drop weight, a striker (upper anvil, 2.5 kg for solid samples and 1.0 kg for liquid samples), a bottom anvil, a microphone sensor, and a peakmeter.



Figure 1. Drop hammer system at LLNL

For each drop, sample (35 mg for solid or 45 microliter for liquid) is placed on the bottom anvil surface and impacted by the drop weight from different heights. Signs of reactions upon impact are observed and recorded. These signs include noises, flashes or sparks, smoke, pressure, gas emissions, temperature rise due to exothermic reaction, color change of the sample, and changes to the anvil surface (noted by inspection). For solid samples, a “GO” was defined as a microphone sensor (for noise detection) response of ≥ 1.3 V as measured by a peakmeter. The higher the DH_{50} values, the lower the impact sensitivity. The method used to calculate DH_{50} values is the “up and down” or Bruceton method. PETN and RDX have impact sensitivities of 15 and 35 cm, respectively. TATB has impact sensitivity more than 177 cm. For liquid samples, a “GO” was determined by the noise levels as measured by the peakmeter, appearance of flashes, temperature rise of the anvil, and visual inspection of the anvil surface. Two liquid samples TMETN and FEFO have impact sensitivities of 14 and 32 cm, respectively. Figure 2 shows a “GO” event observed during the impact sensitivity test; flashes appeared as the drop weight impacted the sample.

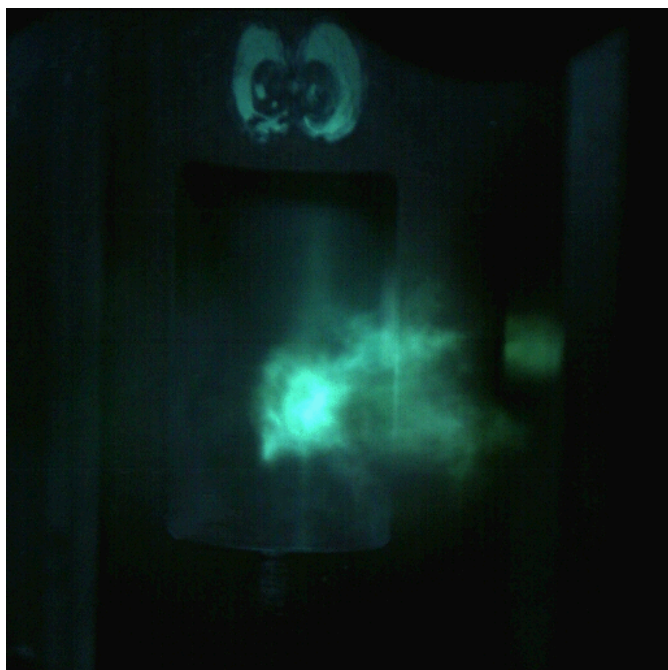


Figure 2. A “GO” event observed during the impact sensitivity test; flashes appeared as the drop weight impacted the sample.

2. Frictional Sensitivity

A BAM friction sensitivity test machine, as shown in Figure 3, was used to determine the frictional sensitivity. The system uses a fixed porcelain pin and a movable porcelain plate that executes a reciprocating motion. Weight affixed to a torsion arm allows for a variation in applied force between 0.5 kg to 36.0 kg. The relative measure of the frictional sensitivity of a material is based upon the smallest load (kg) at which reaction occurs for a 1-in-10 series of attempts. The lower the load values, the higher the frictional sensitivity. PETN has a frictional sensitivity of 6.4 kg.

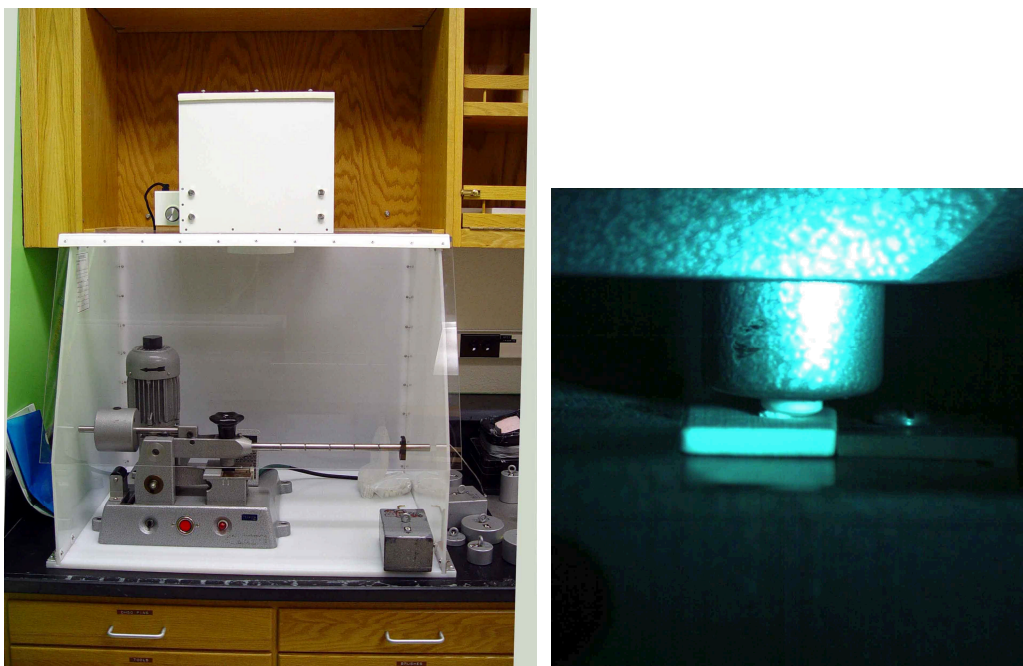


Figure 3. Friction sensitivity test machine; (a) front view, left; (b) pin and plate with sample in between in a close-up view, right.

3. Spark Sensitivity

The static spark machine at LLNL is used to evaluate the electrostatic discharge hazards (human ESD) associated with the handling of explosives. The machine was custom-built almost 30 years ago and consists of a capacitor bank (up to 20,000 pF), a voltage meter, and a discharge circuit, as shown in Figure 4. An adjustable resistor up to 510 ohms (chosen to simulate human body) is wired to the discharge circuit. A 5-mg sample is placed in a Teflon washer sealed to a steel disc and covered with a Mylar tape. High static voltage (up to 10 kv) is applied and discharged to the sample. Evidence of reaction is judged from the condition of Mylar tape, smokes, and color change of the sample. Voltage, capacitance, and resistance can be adjusted to achieve the desired static energy. The results obtained are expressed as a zero in 10 or one-in-ten at a specific voltage and joules. One reaction in ten trials at ≤ 0.25 joules is considered spark-sensitive. Primary explosives show reaction at 0.1 joule.



Figure 4. Spark test system